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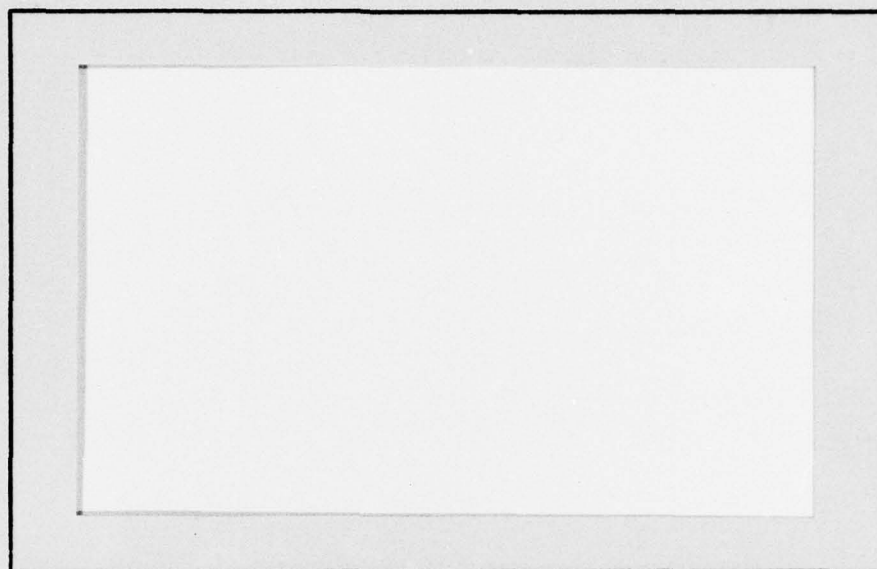
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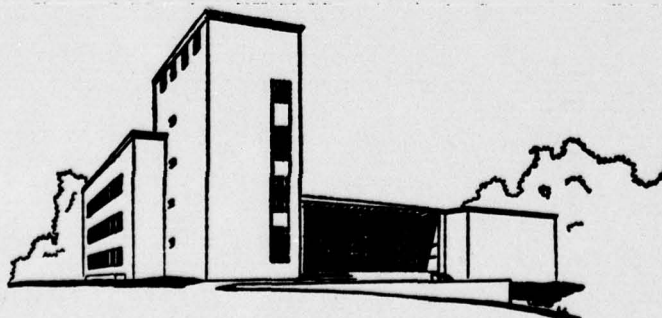
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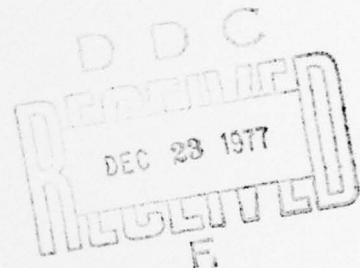
by

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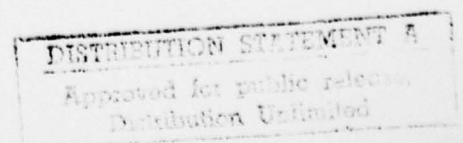


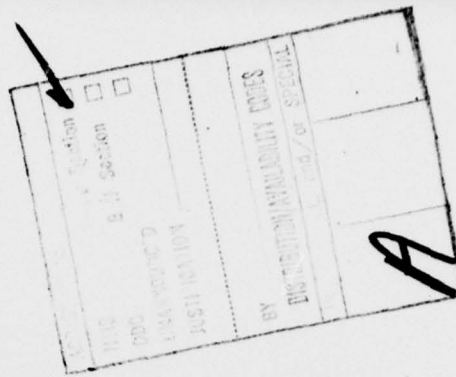
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BARGAINING ASSIGNMENT AND OFFICER ROTATION MODELS IN THE U. S.
NAVY

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ABSTRACT

The reassignment of naval officers at the end of their duty tours involves both gross and detailed planning considerations. The AMIS program for making gross assignments of officers to jobs was developed earlier by Cass, Charnes, Cooper, and Niehaus. To help with the detailed problem we have devised the bargaining assignment program BUPERS which is capable of quickly solving the problem of assigning several hundred officers to billets. We present brief discussions of both these programs, as well as a scoring program.

1. INTRODUCTION

The policy of the U. S. Navy is to rotate the jobs of all naval officers periodically in order to give them requisite experience both at sea and ashore. The usual duty period is 2-3 years, and it is typical to alternate between ship and shore duty. While this policy is beneficial for the training and experience of officers, it poses unique problems to the Bureau of Naval Personnel (BUPERS) which performs the function of planning and making the actual duty assignments of officers. There is a natural conflict between the desire to fill the open billets with the "best possible man for the job," and the desire to "create an attractive career pattern for each officer." This dicotomy has led to what we characterize as the bargaining assignment problem. In this paper we discuss this problem in both gross and fine detail and outline various methods of solution by means of officer rotation models.

An officer is a member of the command structure of the U. S. Navy who has one of the 10 navy ranks or grades: Captain, Commander, Lieutenant Commander, Lieutenant, Lieutenant (JC), Ensign, and 4 grades of warrant officer. The designator of an officer is a four digit number that designates his background training and area of competence: for instance, an 1100 designator indicates a line officer, an 1120 designator indicates a submarine officer; a 1320 designator indicates a naval flight officer; etc. Some officers have subspecialty codes that indicate special training or experience such as: a master's degree in computer science; experience in applied electronics, etc. A billet indicates a specific kind of job at a specific location: e.g., flight officer at Pensacola; executive officer on Destroyer XXX; etc.

The priority of a billet is a number between 1 and 4 indicating the relative importance of the billet according to the following rules:

<u>Priority</u>	<u>Meaning</u>
1	Essential for accomplishment of a unit's mission must not be <u>gapped</u> , that is, it must always be filled; and only officers fully qualified may be assigned to the billet.
2	Very important to the unit's activity. A small percentage of such billets may be gapped, if necessary for short periods; a few may be filled with less qualified officers.
3	Important to the function of the unit's mission; however, the billet may be gapped, or filled with less than qualified officers, if necessary.
4	An optional function; desirable, but not essential for effective operation of the unit. May be gapped, or filled with less than qualified officers depending on the number of officers available.

Since an officer who is to be assigned to a new job cannot himself appear in person to apply for the job, he is represented by an officer in BUPERS called a detailer, who is in charge of a group of officers of similar designators and experience. It is the detailer's job to read the fitness reports of each officer in his group, acquaint himself with the officer's preferences, past performance, special qualifications, etc. The detailer tries to obtain the best assignment for an officer that his record will support. The detailer is generally in personal contact with each of his officers.

In a similar manner, the placement officer is responsible for a group of billets, which he attempts to fill with the best available officers. This officer is primarily concerned with filling each billet with the best officer available. His responsibility is to the commanding officer of the activity concerned.

The officer rotation problem is the problem of assigning all available officers to available billets, without regard to individual identities of either officers or billets, in such a way to maximize the overall quality of assignment. The program AMIS was developed to solve this problem, and its results are used in long range planning. This program is described in Sections 2 and 3.

The bargaining assignment problem is the process that goes on between the detailers who have the "bodies" and the placement officers who have the "billets." In order to solve this problem, the individual characteristics of officers and billets must be taken into account. The programs DESIRE and BUPERS were developed to solve this problem. They are described in Sections 4 and 5 of this paper.

In the past the problems described above have been solved manually, and certainly a large part of the problem will continue to be solved in the same manner. However, because these problems involve large numbers of officers and billets, and large quantities of qualitative data, the Navy is gradually increasing computerized officer record keeping. The purpose of this paper is to describe the computer programs that have been developed to assist BUPERS decision makers in making officer assignment decisions.

2. SUMMARY OF THE AMIS PROGRAM

Most of the material of the present section is taken from the reference [1] which details the state of research by D. Cass, A. Charnes, W. W. Cooper, and R. J. Niehaus, when the AMIS program was developed. AMIS is an acronym for "Automated Management Information System." Because of limited space we shall give only a brief description of the current version of this program.

The data needed by the program consists of officer data, summarized in Figure 1(a) and billet data, summarized in Figure 1(b). The current AMIS program takes into account factors 1 and 2 of the officer data and factors 1, 2, and 3 of the billet data and sets up a linear programming model whose constraints are indicated by items 1, 2, and 3 of Figure 2 and whose objective function is item 1 of Figure 3. In other words the current AMIS program finds the optimal match of officers, indicated by designator and grade, with billets, indicated by designator, grade and priority.

(a) Officer Characteristics		(b) Billet Characteristics	
*1	Designator	*1	Designator
*2	Grade	*2	Grade
3	Dependents	*3	Priority
4	Location	4	Location
5	Subspecialty	5	Subspecialty
6	Additional Qualification	6	Additional Qualification
	Designators		Designators
7	Past Performance	7	Relative importance of
8	Preference for Billets		Qualifiers

* Factors currently implemented in AMIS

Figure 1

Constraints	
*1	Rotatable officers available
*2	Billets available
*3	Distribution requirements
4	Permanent Change of Stations Funds Available

* Factors currently implemented in AMIS

Figure 2

Objectives	
*1	Maximize qualification match
2	Minimize travel costs
3	Maximize officer preferences

* Factors currently implemented in AMIS

Figure 3

In addition to the above matching rules there are numerous other policy factors that must be taken into account. For instance, there may be an oversupply of one grade or kind of officer, and an undersupply of another grade or kind. We can improve on the quality of the match by making use of the following policies:

1. Up detailing, that is, the assignment of an officer of a given grade to a billet requiring a higher grade.
2. Down detailing, the assignment of an officer of a given grade to a billet requiring a lower grade.
3. Cross detailing, that is the assignment of an officer of a given grade and a designator to a billet requiring the same grade, but a different designator. Only certain cross detailing assignments are permitted.

4. Relative fill ratio rules. These rules can be summarized by

Priority	1	2	3	4
Fill-ratio	100	75	56	42

What these mean are: first fill all priority 1 jobs; then fill at least 75 percent of priority 2 jobs before any priority 3 jobs are filled; fill 56 percent of priority 3 jobs before any priority 4 jobs are filled, etc.

5. Priority Allocation Method (PAM). The so-called multi-designator jobs have 1000 and 1050 designators; these can be filled by a wide variety of other designators. The PAM program simply gives a fair proportional distribution of the officers so assigned to these jobs.

The way these policy rules are implemented is by a scoring system, whose rules are summarized in Figure 4. Further details of the scoring, with examples provided by the DESIRE program are given in Section 4.

Policy Rules used in AMIS	
1	Up detailing is preferable to down detailing.
2	If an officer is up detailed, send him to a lower priority job.
3	If an officer is down detailed, send him to a higher priority job.
4	If an officer is cross-detailed, send him to a lower priority job.
5	Don't up or down detail more than one grade (with a few exceptions).
6	Allocation of multi-designator billets is by PAM.
7	If the officer inventory is less than the billet requirements, use the fill ratio priority method to fill billets.

Figure 4

Even though the linear program actually used in AMIS is a transportation model for which very fast special purpose codes have recently been developed [2,3], the program actually used in AMIS is an ordinary linear programming code. It currently takes 25-30 minutes of 360-65 time to solve the problem. (Plans exist for reducing this time, see Section 3.)

Once the problem is solved, the following reports are printed by AMIS:

- A. The Macro Distribution
 - 1. Distribution of inventory
 - (a) By number to designator/grade billets

- (b) By percentage to designator/grade billets
- (c) By number to grade billets
- 2. Allocation to billets
 - (a) By number from designator/grade inventory
 - (b) By percentage from designator/grade inventory
 - (c) By number from grade inventory
- B. The Micro Distribution
 - 1. For each Placement Deck
 - (a) Authorized billets by grade/designator
 - (b) Plan distribution by grade/designator
 - (c) Current on board distribution by grade/designator

In spite of some implementation difficulties AMIS has been accepted, is run quarterly, and the reports are widely distributed for distribution guidance. The primary reasons these reports have proven useful are:

- (1) They present an achievable plan that optimizes use of the available officer inventory, both in the macro sense, and at the unit level.
- (2) They show where officer excesses exist, and how they should be used. They also show where officer deficiencies exist, and suggests ways to compensate.
- (3) They give a numerically feasible plan for apportioning officers to multi-designator billets.
- (4) They provide both the detailer and the placement officer useful information for short-term planning.
- (5) They help answer questions such as: "Why didn't I get the grade of officer I asked for in this position?"
 "Why can't Officer X get the billet he asked for?"
 "Why is Captain Z assigned to a commander's billet?"

In summary, we can say that the initial phases of development and implementation of the AMIS program are complete, and that the program is installed and in use, at least for gross planning purposes, on a working basis in the U. S. Navy. We discuss plans for modifications and additions next.

3. PLANS FOR MODIFICATIONS AND EXTENSION OF AMIS

As indicated in the previous section the actual implementation of AMIS encompasses some, but not all, of the ideas conceived of by the original developers [1] of AMIS. In addition, new developments in computing power of transportation models have made it possible to significantly speed up the computation of the linear programming model. Finally, other ideas are extensions of the model have been suggested by the authors and others. We list these ideas in the approximate order in which development is planned.

- (1) Replace the linear program imbedded in AMIS with a fast transportation code.
- (2) Add items 3 - 6 to Figure 1(a).
- (3) Add items 4 - 6 of Figure 1(b).
- (4) Take into account item 4 of Figure 2.
- (5) Take into account items 2 and 3 of Figure 3.

As to the status of these efforts, (1) is well underway and will be completed in the next few months. The rest of these will be implemented and tested first in the programs DESIRE and BUPERS to be discussed in Sections 4 and 5, and then, if appropriate, incorporated into the AMIS program.

4. THE PROGRAM DESIRE

When AMIS considers a match between an officer, indicated by a designator and grade, and a billet, indicated by a designator, grade, and priority, it assigns a score according to the policy rules given in Figure 4. The program DESIRE was written to print out these scores so that they could be compared to see whether the desired results were being obtained.

To understand how the scoring is done, we have reproduced an example of the Up/Down detailing matrix in Figure 5, and a portion of the Cross Detailing Matrix in Figure 6. To see how these two

		CAPT	CDR	LCDR	LT	LTJG	ENS
1	CAPT	1000	700	0	0	0	0
2	CDR	850	1000	700	0	0	0
3	LCDR	0	850	1000	700	0	0
4	LT	0	0	850	1000	700	0
5	LTJG	0	0	0	850	1000	850
6	ENS	0	0	0	500	850	1000

Part of the Up/Down Detailing Matrix

Figure 5

Billet Designators

		1000	1050	1120	1170	1310	1320
Officer	1100	1000	550	0	0	650	650
Designa-	1110	850	850	550	0	0	0
tors	1170	0	0	700	1000	0	0
	1310	850	850	500	0	850	0

Part of the Cross Detailing Matrix

Figure 6

matrices are combined to give a score, consider an 1170/5 officer, that is, a Lieutenant (JG) having a 1170 designator. If we enter Figure 5 we see that if he is up detailed he gets a score of 850, if he is correctly detailed he gets 1000, and if he is down detailed he gets 700. Also entering Figure 6 we see that the only billets to which he can be assigned have designators 1120, which gives a score of 700, and 1170, which gives a score of 1000. Thus if the 1170/5 officer is assigned to a 1170/5 billet he gets a total score of 2000, but if he is up, down, or cross detailed he will get less. The actual scores for all possible billets to which this officer can be assigned are shown in Figure 7.

Priorities	Up Detailing		Correct Detailing	Cross Detailing	Down Detailing	
	1170/4	1120/4	1170/5	1120/5	1170/6	1120/6
1	1860	1552	2000	1694	1690	1384
2	1870	1563	2000	1695	1680	1375
3	1880	1575	2000	1697	1670	1367
4	1890	1586	2000	1698	1660	1358

Sample scores for an 1170/5 officer assigned to all allowable billets. Compare these scores with the policy rules given in Figure 4.

Figure 7

The way in which the actual scores are varied to prevent their being merely the sum of the two scores in the Up/Down and Cross Detailing matrices is too involved to explain here. However, the reader can see that the scores assigned reflect the policy rules of Figure 4.

The purpose of writing the DESIRE program was to permit study of the effects of changes in policy decisions on the resulting scores. It has also brought out the difficulty of scoring by means of rigid rules. Any scoring scheme leads to unpredictable and oft-times paradoxical results. This program permits the user to quickly locate such paradoxes in the scores before the policies are implemented in other programs such as AMIS or the BUPERS program to be described next.

5. THE PROGRAM BUPERS

The usual bargaining assignment problem faced by a detailer or assignment officer is that of matching 100 to 200 officers and billets at a time. In this case he has to consider real people and real jobs with their full descriptions. It is also true that the actual constraints faced in this problem are much more complicated than those given in Figure 3. For instance, consider the constraints

implied by the following phrases: "Don't assign officer X to billet Y or else he will have the same commanding officer." "Admiral Z wants officer W in billet Y." "Officer U must stay where he is because of a health problem in his family." "Don't send an officer with more than 2 dependents out of the country." These real constraints are so specialized and complicated that it is impossible to write them as general linear programming constraints.

Instead, the program BUPERS was developed to be run on a real time basis which a number of easily used conversational commands that the decision maker can use to change the originally stated transportation problem into the one that takes into account these additional constraints. The program is easy to learn and use, since implementing the conversational command requires typing only one or two letters, as can be seen by referring to Figure 8, where a list of the currently available commands is given.

Most of these commands can be understood from Figure 8. However, the RQ, RD, and RDQ commands need further explanation. The RQ demand causes the computer to solve the assignment problem with the maximum qualification objective, just like that of AMIS. The RD command causes the computer to solve the assignment problem with the minimize person-mile objective function computed as follows: Each location of officer or billet is recorded by its latitude and longitude. The computer computes the great circle distance between the two and multiplies by a number indicating the number of dependents the officer has, thus obtaining person-miles for that particular officer/billet match. The command RDQ permits the user to solve

Command	Meaning
RQ	Solve the problem with maximum qualification objective
RD	Solve the problem with minimum distance objective
RDQ	Solve the problem with weighted distance-qualification objective
LO	List officers to be assigned
LB	List billets to be assigned (with priorities)
B	Force billet to be assigned
O	Force officer to be assigned
OB	Assign an officer to given billet
POB	Prevent assignment of an officer to a given billet
AO	Add officer to officer list
AB	Add billet to billet list
DO	Delete an officer from officer list
DB	Delete a billet from billet list
BG	Change billet grade
BD	Change billet designator

List of conversational commands for BUPERS program

Figure 8

the assignment problem with a weighted combination of the qualification and distance objective functions.

A typical use of the program would begin with the use of the LO and LB commands to list the officers and billets to be assigned. Then the user might get an initial solution of the problem with the RQ command which uses the maximum qualification objective. Upon looking at the solution, he may find that some officers with many dependents are sent to locations far away from their present location. Hence he might run with the RD command which minimizes the person-mile objective. This solution may not assign officers to billets the user wishes them to go; he can correct this by using the OB command. He can equally well prevent undesired assignments by the POB command. He can also add or drop officers or billets by using the AO, AB, DO or DB commands. He may wish to change a billet grade or designator by using the BG or BD commands. Finally, he may solve the problem several times with the RDQ command using various weights to combine the objective functions together to obtain the correct mix of the maximize qualification and minimize person-mile objectives.

As can be seen, the program BUPERS permits the user to solve the initial problem, make changes in the problem, solve again, etc., each time looking at the resulting solution to see whether the assignment is desirable from various points of view. In this way the user can change the problem until he obtains an officer/billet assignment he finds satisfactory.

6. FUTURE PLANS

This paper may be regarded as a status report on the progress of development of these programs. Many things remain to be done. Section 3 gave the changes desired in AMIS. We plan to add the capability of handling subspecialty codes first to DESIRE, then to BUPERS, and then, if desired to AMIS. Later, once the data collection method has been devised, we plan to add officer performance and preferences to the objective functions of all codes in approximately the same order.

In the long run, we expect that all officer files will be put on a computer so that any of these problems can be constructed automatically by having the computer search the files for available officers and billets fitting certain rules. In this way we plan to develop a man-computer solution technique for a problem that is now solved manually.

In the development of all these ideas, we intend to give frequent demonstrations of working programs to the assignment and

detailer officers to see if they like the current conversational commands, and obtain suggestions for new commands or modifications of old ones, etc. By involving potential users in the program design and development, it is hoped that the implementation problem will be largely solved, and that we will obtain high user acceptance of the final version of the codes.

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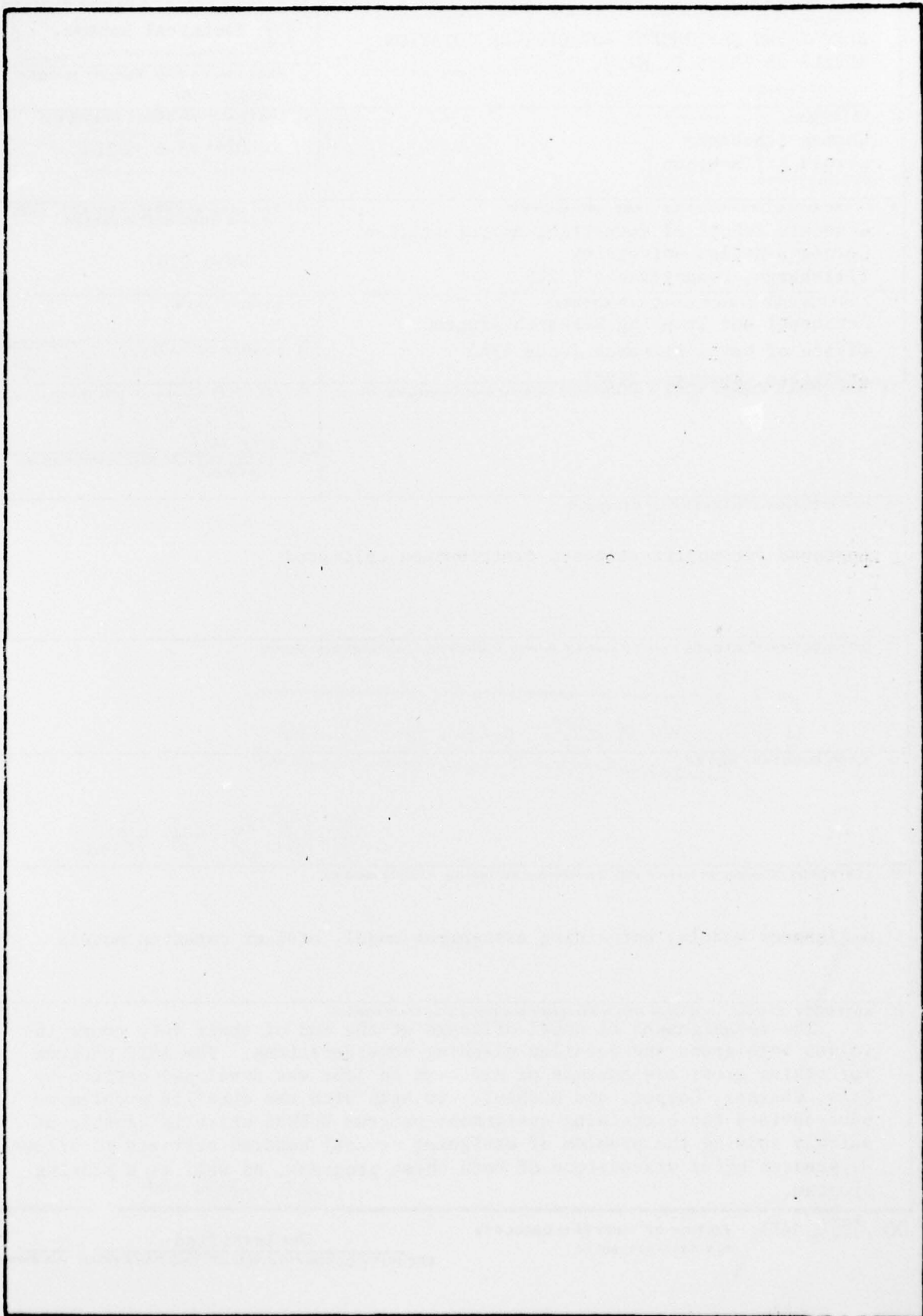
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